NATURAL RESOURCES CONSERVATION SERVICE

CONSERVATION PRACTICE STANDARD

UNDERGROUND OUTLET

(Ft.)

CODE 620

DEFINITION

A conduit installed beneath the surface of the ground to collect surface water and convey it to a suitable outlet.

PURPOSE

Dispose of excess water from terraces, diversions, subsurface drains, surface drains, trickle tubes or principal spillways from dams (outside the dam area only), or other concentrations without causing damage by erosion or flooding.

CONDITIONS WHERE PRACTICE APPLIES

This practice applies where:

- Excess surface water needs to be disposed of
- A buried outlet is needed for Diversions (362), Terraces (600), or similar practices
- An underground outlet can be installed that will safely dispose of excess water
- Surface outlets are impractical because of stability problems, climatic conditions, land use, or equipment traffic

CRITERIA

Capacity. The underground outlet shall be designed, alone or in combination with other practices, with adequate capacity to insure that the terrace, diversion, or other practices function according to the standard for the specific practice.

For example, an underground outlet can be used in combination with a grassed waterway or a surface drain to carry part of the design flow. The underground outlet shall have adequate capacity to remove the design volume of surface water from natural or constructed basins within 48 hours or less for row and other commodity type crops.

Inlet. An inlet can be a collection box, a perforated riser, or other appropriate device. Its capacity shall be adequate to provide the maximum design flow in the conduit. Flow-control devices shall be installed as necessary. Perforated risers must be of durable material, structurally sound, and resistant to damage by rodents or other animals. If burning of vegetation is likely to create a fire hazard, the inlet shall be fire resistant. Blind inlets can be used where they are effective. Collection boxes must be large enough to facilitate maintenance and cleaning operations. The inlet must have an appropriate trash guard to insure that trash or other debris entering the inlet passes through the conduit without plugging. It must also have an animal guard to prevent the entry of rodents or other animals.

Inlets shall have a minimum inside diameter of 4.0 inches. All intake opening shall be smooth and burr free. The inlet capacity shall be equal to or greater than the design discharge rate used to compute basin storage volume. The inlet capacity shall be calculated assuming that at least 50 percent of the openings on the side of the inlet are plugged and the water surface is at a maximum of 70 percent of the design ridge height.

Inlet caps or screens shall be removable on inlets with orifice plates. The maximum screen opening dimension shall not exceed one-half the orifice diameter on inlets with orifices.

Orifice plates, when used shall be made of metal or durable plastic, fit tight against the seat of connectors and have a smooth edge. Use NEH, Part 650, Chapter 8, Terrace, Exhibit 8-5 to determine capacity of orifice plates. Appropriate equations shall be used to determine capacity of other types of devices which restrict flow. Submergence of the orifice will reduce the orifice head pressure. Use the reduced head pressure to determine submerged orifice capacity.

Pressure-relief wells shall be designed and installed as needed to control pressure (See Vertical Outlet section for design criteria). Pressure may also be controlled by restricting flow into the conduit or by increasing conduit size.

If junction boxes and other structures are needed, they shall be designed and installed in a manner that facilitates cleaning and other maintenance activities.

The fitting used to connect the inlet pipe to the underground outlet shall be water tight. Fittings shall comply with underground outlet manufacturer's recommendations and be of equivalent strength and pressure rating. No fittings shall reduce or impair the overall integrity or function of the underground outlet system.

A minimum of 3-inch nominal diameter and 8 feet long non-perforated pipe shall be installed (horizontally) immediately downstream of any inlet.

An additional subsurface drain may be installed as an extension to the inlet to improve access and farmability. This subsurface drain shall meet the requirements of Subsurface Drains (606) and be a minimum of 10 feet in length. Manufacturer approved end caps or concrete shall be used to cap the open end(s) of the subsurface drain.

Hydraulics. Underground outlets shall be continuous conduits, tubing, or tile. Joints shall be hydraulically smooth, and the materials and methods used shall be recommended by the manufacturer. If a pressure system is used, joints shall be adequate to withstand the design pressure, including surges and vacuum. The maximum velocity must not exceed the velocities set forth in Table 1.

Lines shall be adequate to carry the design flow when the outlet and all inlets are operating at design capacity. Positive grade shall be maintained in all sections of an underground outlet. Capacity shall be based on the pipe size or on other flow control devices to prevent water from the upper inlets from discharging through the lower inlets. The minimum conduit diameter shall be 4 inches, except the offset pipe between the surface intake riser and underground outlet or tile main may be 3 inches.

Table 1. MAXIMUM PERMISSIBLE VELOCITIES FOR CONDUIT LINES

Soil Texture	Perforated Corrugated Plastic Tubing ft/sec	Non Perforated Corrugated Plastic Tubing ft/sec	Dual Wall Polyethylene Pipe [1] ft/sec	PVC Smooth Steel Corrugated Steel (Watertight Joints)
Sand & Sandy Loam	3.5	8.0	20.0	No limit
Silt & Silt Loam	5.0	10.0	20.0	No limit
Silty Clay Loam	6.0	12.0	20.0	No limit
Clay & Clay Loam	7.0	12.0	20.0	No limit
Course Sand and Gravel	9.0	12.0	20.0	No limit

[1] Dual wall PE pipe and joints shall meet ASTM Standards F477, F667, F2306, and D3212. All joints and fittings shall be watertight, capable of withstanding 10.8 psi of internal pressure.

Materials. Materials shall meet or exceed the design requirements against leakage and shall withstand internal pressure or vacuum and external loading. Plastic, concrete, aluminum, and steel shall meet the requirements specified in the applicable ASTM standard. All materials specified for Subsurface Drains (606) can be used for underground outlets. Conduits, however, can be perforated or nonperforated, depending on the design requirements. A filter fabric wrap (sock) or equivalent shall be used if migration of soil particles around the conduit is anticipated. All exposed plastic materials shall be protected from degradation due to exposure to sunlight. The fill height over the underground outlet conduit or pipe shall not exceed the values shown in Table 2 or Table 3, depending on the type of conduit material. The use of different pipes and/or pipe cover parameters is acceptable if all of the following conditions are met:

- The pipe shall be of a type listed in NEH, Part 650, Chapter 14, Section 650.1425, Materials
- An engineering load analysis is completed in accordance with the parameters and procedures defined in NEH, Part 636, Chapter 52, Structural Design of Flexible Conduits
- Installation specifications have been developed for the specific site conditions and pipe material used

TABLE 2. ALLOWABLE COVER ON METAL PIPE (STEEL AND ALUMINUM)

Material Type	Diameter Inches	Minimum Pipe Cover Feet	Non - Trench Maximum Earth Fill Pipe Cover Feet	Maximum Pipe Cover for Pipes Installed in a Trench Condition Feet
Helical Corrugated Metal Pipe [1] (Steel)	6 - 18	1.0	20.0	20.0
Annular Corrugated or Helical Corrugated Metal Pipe [2] (Aluminum)	6 – 10	1.0	20.0	20.0
Annular Corrugated or Helical Corrugated Metal Pipe [3] (Aluminum)	12 - 18	1.0	20.0	20.0
Smooth Steel Pipe [4]	4 - 16	1.0	20.0	20.0

[1] ASTM's A760, A762, and A929 with a minimum wall thickness of 16 gauge (either 1-½ inch by ¼ inch corrugations or 2-$^{2}/_{3}$ inch by ½ inch corrugation)

[2] ASTM B745 with 1-½ inch by ¼ inch corrugations and a minimum wall thickness of 16 gauge

[3] ASTM B745 with 2-$^{2}/_{3}$ inch by ½ inch corrugations and a minimum wall thickness of 16 gauge

[4] Minimum wall thickness is ¼ inch

TABLE 3. ALLOWABLE COVER ON PVC AND PE PIPE

Material Type	Diameter Inches	Minimum Pipe Cover Feet [1]	Non - Trench Maximum Earth Fill Pipe Cover Feet [2]	Maximum Pipe Cover for Pipes Installed in a Trench Condition Feet [3]
PVC SDR41 [4]	4 – 12	2.7	5.8	12.2
PVC SDR 32.5 [5]	4 – 12	2.2	8.4	14.2
PVC SDR 26 [5]	4 – 12	2.1	12.4	17.9
PVC SDR 21 [5]	4 – 12	2.0	19.7	20.0
PVC Schedule 40 [5]	4	2.0	20.0	20.0
PVC Schedule 40 [5]	6	2.0	15.0	20.0
PVC Schedule 40 [5]	8	2.1	11.7	19.1
PVC Schedule 40 [5]	10	2.1	9.6	16.8
PVC Schedule 40 [5]	12	2.1	8.9	15.5
PVC Schedule 80 [5]	4 – 12	2.0	20.0	20.0
HD Corrugated Plastic PE [5]	3 – 15	2.4	7.3	11.6
Dual Wall PE [6] (corrugated exterior w/ a smooth wall interior)	4 - 15	2.2	7.0	11.2

[1] PVC and PE pipes were analyzed with a modulus of soil reaction, E' = 400 psi and a H20 Live Load Classification (P_L = 16000 lbs)

[2] PVC and PE pipes were analyzed with a modulus of soil reaction, E' = 200 psi

[3] PVC and PE pipes were analyzed with a modulus of soil reaction, E' = 400 psi; however, the width of the pipe trench from the bottom to at least 6 inches above the pipe shall not exceed the pipe diameter plus 24 inches or else the "Non-Trench Maximum Earth Fill Pipe Cover" shall be used as the limiting control factor.

[4] ASTM D2241 Designation 1120 (12454-B), 1220 (12454-C), and 2120 (12454-D)

[5] ASTM F405 or F667 depending on pipe diameter, AASHTO M252 and M294

[6] ASTM's F405, F667, D3350, AASHTO M252 and M294

Outlet. The outlet shall be sufficiently stable for all anticipated flow conditions. It shall be designed for the maximum anticipated water surface at design flow. A continuous section of closed conduit, at least 20 feet long, or a headwall shall be used at the outlet. If a closed conduit is used, it shall be durable and strong enough to withstand all anticipated loads, including those caused by ice. Outlets shall not be placed in areas of active erosion. If fire is a hazard, the outlet shall be fire resistant. All outlets must have animal guards to prevent the entry of rodents or other animals. Animal guards must be hinged to allow passage of debris.

Vertical Outlet. A vertical outlet (i.e.: Relief Well) may be used to discharge water to the ground surface when underground outlet capacity or cover limitations exist. All vertical outlets shall have adequate grating for safety and animal exclusion purposes as well as adequate field markings for machinery and equipment avoidance.

An adequate and stable surface outlet for the design outflow and velocity shall be provided for the overflow from the vertical outlet. When a vegetated channel or waterway is to be used for the overflow, vegetation shall be established prior to installing the outlet.

The minimum vertical outlet size shall be one conduit size larger than the incoming underground line but not less than 5 inches in diameter. The vertical outlet flow velocity shall not exceed 2 feet per second. In the case of multiple lines entering the vertical outlet, the cross-sectional area of the vertical outlet shall be a minimum 1.5 times the sum of the cross-sectional areas of the incoming lines. The vertical outlet diameter shall be large enough to provide adequate space along the circumference of the pipe in order to fabricate both incoming and outgoing pipeline stubs and allow for maintenance.

The vertical outlet shall extend to the ground surface but no more than 6 inches above the surrounding natural ground. The minimum depth from the ground surface to the bottom of the vertical outlet shall be that which will provide the required depth of cover for the attached pipelines.

CONSIDERATIONS

Consider effects on the water budget, especially on volumes and rates of runoff, infiltration, evaporation, transpiration, deep percolation, and ground water recharge.

Consider effects on the volume of downstream flow that might cause undesirable environmental, social, or economic effects.

Evaluate potential use for water management.

Consider effects on erosion and the movement of sediment, pathogens, and soluble and sediment-attached substances that would be carried by runoff.

Consider effects on the visual quality of downstream water resources.

Consider the construction related effects on the quality of downstream watercourses.

Consider effects on wetlands or water related wildlife habitats.

Evaluate potential impact on water quality due to agri-chemicals in outflow.

Consider depth of underground outlet in regard to tillage equipment depth and maintenance, if applicable.

Consider installing a permanent field marker next to the outlet of a vertical outlet to reduce the risk of equipment damage.

PLANS AND SPECIFICATIONS

Prepare plans and specifications for underground outlets that describe the requirements for applying this practice according to this standard.

Iowa Standard Drawing Number; IA-854 (Underground Outlet) or equivalent shall be utilized for the construction of this practice or incorporated into the plans for the practice it serves.

Iowa Construction Specification IA-620 (Underground Outlet) shall be followed for the installation of underground outlets. Additional construction specification may be added to address other installation issues.

OPERATION AND MAINTENANCE

Prepare an operation and maintenance (O&M) plan for the landowner. The minimum requirements to be addressed in a written operation and maintenance plan are:

- Periodic inspections, especially immediately following significant runoff events, to keep inlets, trash guards, and collection boxes and structures clean and free of materials that can reduce flow
- Prompt repair or replacement of damaged components
- Repair or replacement of inlets damaged by farm equipment
- Repair of leaks and broken or crushed lines to insure proper functioning of the conduit
- Periodic checking of the outlet and animal guards to ensure proper functioning
- Repair of eroded areas at the pipe outlet
- Maintain adequate backfill over the conduit

REFERENCES

USDA-NRCS, National Engineering Handbook (NEH), Part 650, Engineering Field Handbook (EFH), Chapters 8 and 14

Iowa Drainage Guide, Iowa State University Special Report 13

USDA-NRCS, National Engineering Handbook (NEH), Part 636, Chapter 52